

Carbon Capture and Sequestration Sixth Annual Conference



Expediting Deployment of Industrial-Scale Systems Can It Be Done? How? Concerns?

Update on Canada's CO₂ Capture and Storage Program

Graham R. Campbell

Office of Energy Research and Development
Natural Resources Canada

May 7-10, 2007
Pittsburgh, Pennsylvania

Outline of Today's Presentation



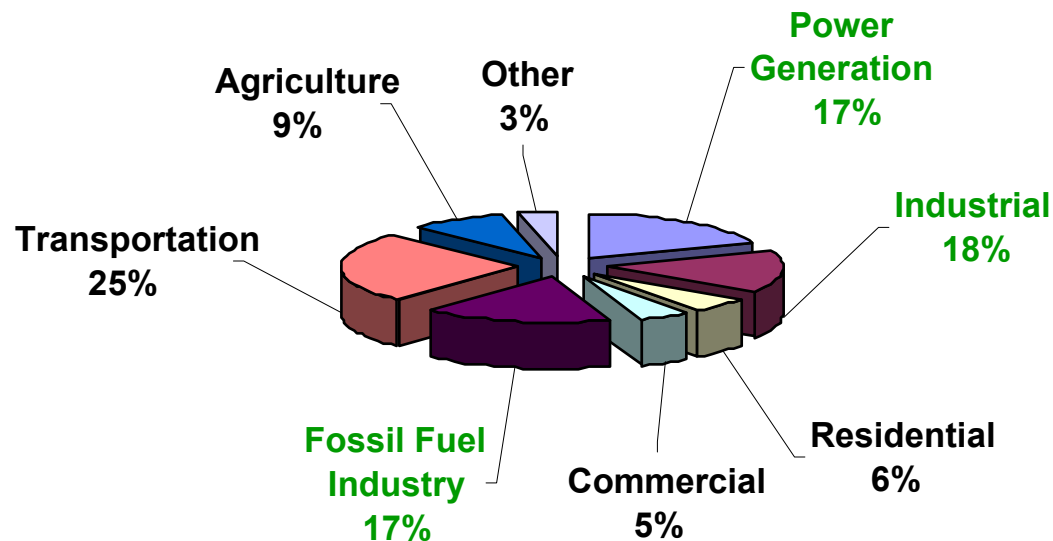
- **CO₂ Capture and Storage (CCS) in Canada**
 - Drivers
- **Recent Developments**
- **Experts' Perspectives on CCS**
- **Emerging Projects**
- **Key Messages**

Why is CCS Important to Canada?

Three Sectors Account for 50%+ of Canada's GHGs



2004 GHG Emissions by Sector (758 Mt)



- Power generation (17%), industrial end-use (18%), fossil fuel supply (17%), dominate Canada's GHG inventory
- Largely point sources – amenable to capture technologies
- Major challenge, and an opportunity, for CCS

Drivers for Widespread CCS

Regulatory, Economic, Investment Cycle



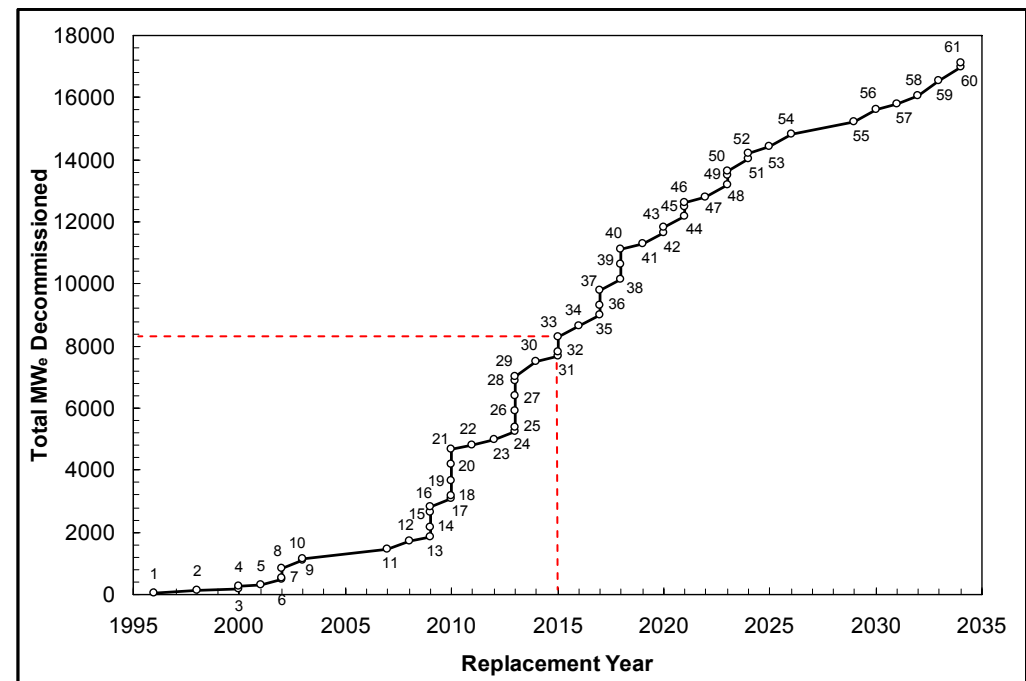
- Timing is auspicious – emerging technologies are ready now for demonstration, and other drivers are coming due – regulatory, economic, capital stock turnover
- Regulatory Drivers:
 - Government of Canada has announced Regulatory Framework for Air Emissions
 - Provides signals to utilities, independent power producers, industry
- Economic Drivers:
 - Experience with CO₂ Enhanced Oil Recovery (EOR) projects has been very positive
 - EOR creates first market for CO₂ – but with stringent requirements for purity, pressure, location
- Major capital investment in the offing in electricity sector - good timing for replacement of aging generating capacity

Drivers for CCS - Electricity Sector

Investment Cycle for Replacing Capital



- Capital stock turnover is on the horizon
 - Many existing coal-fired generation assets beyond mid-life point
 - Assuming a 40-year operational life, about 50% of today's capacity will have reached economic maturity by 2015
 - Defines the "natural cycle" for industry to invest
 - Large investments ahead, but with some uncertainty as to technology choices



(Source: Pearson, 2006)



CCS in Canada

Recent Developments

Canada's CCS Program

A Suite of Interdependent Initiatives



“CCS Program Vision” – Creating the Environment for Implementation of CO₂ Capture, Use and Storage in Canada

Science and Technology

**Developing Frameworks,
Regulations, Practices**

**Strategic Planning, Networks,
International Initiatives**

Emerging Projects

Canada's CCS Program – Updates Today

A Suite of Interdependent Initiatives



“Building Blocks” – Creating the Environment for Implementation of CO₂ Capture, Use and Storage in Canada

Science and Technology

IEA Weyburn-Midale Storage, Monitoring

Assessment of Storage Potential

Enhanced Recovery Oil, Gas

CO₂ Capture Technologies

Developing Frameworks, Regulations, Practices

Storage Regulations

Measure, Monitoring, Verification

Risk Assessment

Public Attitudes, Acceptance

Strategic Planning, Networks, International Initiatives

CCS Task Force

Capacity Building, Transport'n

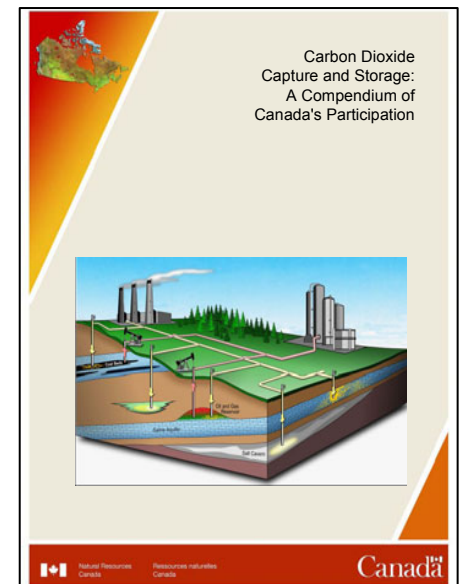
Technology Roadmap, Compendium

International Collaboration, Partnerships

CO₂ Capture and Storage Compendium Actions Taken Since Publication



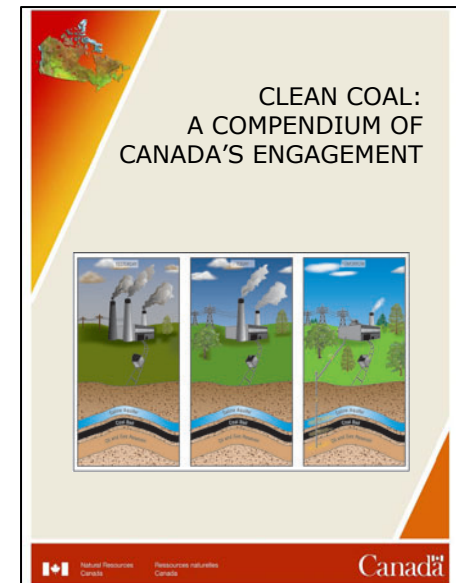
- CCS Compendium is an inventory of Canada's CCS activities, published in May 2006, a "best seller"
- Complements the CCS Technology Roadmap – September 2006
- Developments following publication
 - Technology Status – underinvesting in capture technologies relative to storage technologies
→ additional investments to address technology gaps
 - Policy Context – Regulatory Framework announced on April 26 re long-term air emissions reduction targets
→ developing new technology to support the regulatory framework
 - Coordination and Planning – recognized need for better coordination to set priorities and guide national RD&D efforts → established a Task Force to provide advice on making widespread use of CCS a reality



Clean Coal Compendium Closely Linked to Deployment of CCS



- Designed to bring us up to date on Clean Coal projects and parallel-running activities in Canada – to be released in mid-2007
- Some observations
 - 95 organizations, 86 projects
 - Large number of commercial/demo projects on the drawing boards
 - Many of the nearest term gasification-based plants will utilize by-product of oil sands processing and will be operated in a polygen mode
 - Ongoing feasibility analysis looking at innovative technologies for clean coal
- Excellent, world-class projects are emerging, four categories:
 - Pre-combustion coal 5 projects
 - Post-combustion coal 1 projects
 - Oil sands gasification 5 projects
 - CO₂ capture 2 projects
- Clean coal is a primary driver for CCS deployment



Analysis of Public Attitudes to CCS Public Communications, Outreach



- **An important component of Canada's CCS program**
- **A brochure being developed on the safety and permanence of geologic storage**
 - **Weyburn-Midale project is working with Australia's CO2CRC, Chevron, Rio Tinto and BlueWave Resources, IEA being brought in to the process**
- **Audience for the brochure is the interested public, will be distributed at workshops, public meetings, etc.**
- **A second initiative is to develop a citizen's guide to CCS for those who may have projects in their immediate vicinity - will outline questions that landowners should ask regarding potential projects**
- **Next step is the development of a CCS 101 workshop for the media**
- **Canada is also planning a workshop with international experts on Social Science Research on Public Perceptions of CCS, will examine the best outreach tools to be used for a variety of audiences – Fall 2007**

New Funding – ecoENERGY Technology Initiative CCS Among NRCan's Top Energy S&T Priorities



- ecoENERGY Technology Initiative announced recently by Government of Canada
- Targeted investment of \$230m in research, development and demonstration of clean energy technologies over the next four years
- Key priorities identified, to be confirmed through consultation with industry, provinces - CCS is high on the list of technology priorities:
 - CO₂ Capture and Storage
 - Clean Coal
 - Bioenergy
 - Clean Oil Sands Production
 - Advanced Vehicles – Hydrogen, pHEVs
 - Energy Efficient Industry
 - Efficient Buildings and Communities
 - Next Generation Nuclear
- Action through projects based on public-private partnerships
- Additional program details at:
<http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/index-eng.cfm>

Defining the Way Forward

Canada-Alberta Task Force on CCS



- Much has been achieved, question now is how to achieve widespread deployment
- Canada and Alberta announced a joint task force in March 2007
 - “Canada-Alberta Task Force on CCS”
- **Goals**
 - *“To recommend the best ways for Canada to implement CCS on a large scale”*
 - Identify opportunities for widespread use
 - Identify and assess current obstacles
 - Outline a short list of public policy options for addressing obstacles
 - Identify roles, responsibilities and timelines for different actors in implementation
- **Task Force members from industry, academia**
 - Steve Snyder, President and CEO, TransAlta – Chair of Task Force
 - David Keith, Director, U of Calgary’s Institute of Sustainable Energy, Environment and Economy
 - Kathy Sendall, Senior VP, Petro Canada
 - Ian Anderson, President, Kinder Morgan Canada
 - Patricia Youzwa, President and CEO, SaskPower
 - Ex officio - Deputy Minister, Natural Resources Canada; Deputy Minister, Alberta Department of Energy
- **Timeline**
 - First meeting in March 2007, Final report in November 2007

Upcoming Workshop on CCS

November 2007



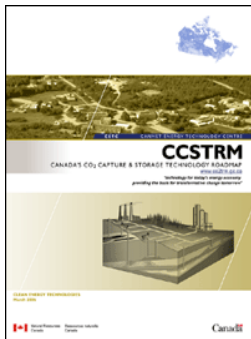
- **On behalf of G8 Ministers/International Energy Agency/Carbon Sequestration Leadership Forum**
- **Final workshop in a series of three, designed to develop final recommendations for early opportunities for CCS**
 - **First two held in San Francisco and then Oslo (June 2007)**
 - **November 27-28 in Calgary, by invitation**
- **Recommendations will be developed thereafter for consideration by the G8 Ministers at their next meeting in Kyoto in spring 2008**
- **Timing and content will complement the work of the CCS Task Force**



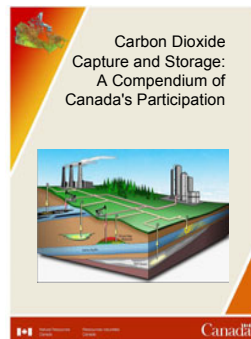
Experts' Perspectives on CCS

CCS Perspectives By Experts

Key Role Identified For CCS Technology



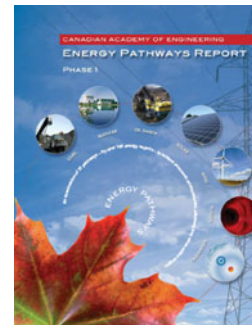
**CO₂ Capture and Storage
Technology Roadmap**



**Carbon Dioxide Capture and
Storage: A Compendium of
Canada's Participation**

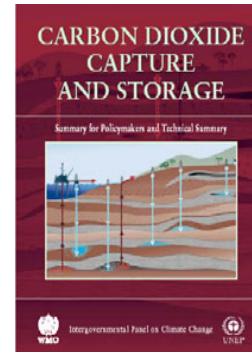


**The Report of the National
Advisory Panel on Sustainable
Energy Science and Technology**

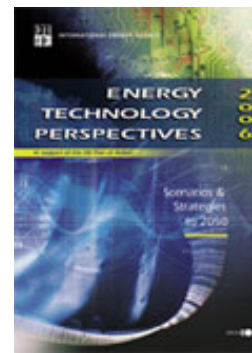


**Canadian Academy of
Engineering**

Energy Pathways Report



**IPCC Special Report on
Carbon Dioxide Capture
and Storage**



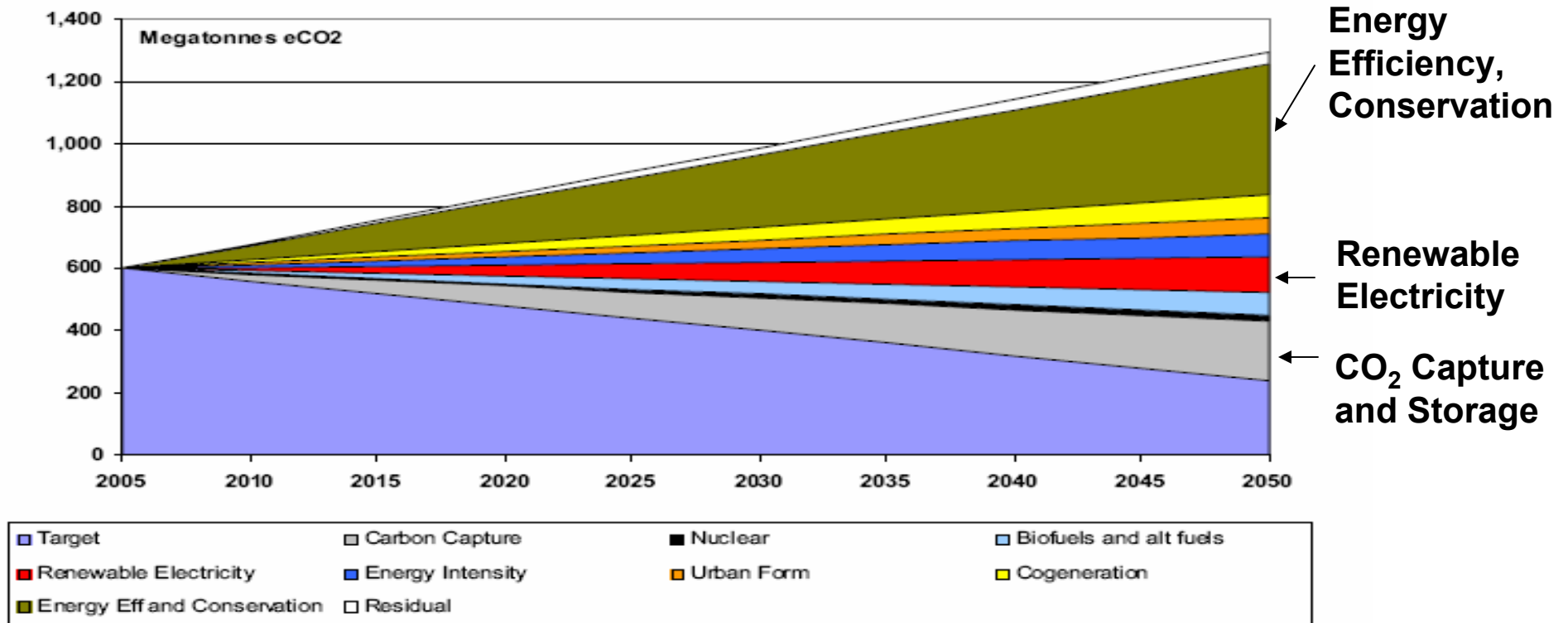
**International Energy Agency
Energy Technology
Perspectives 2006**

Projections of Possible GHG “Wedges” Major Contributions from CCS, Renewable Electricity, Energy Efficiency and Conservation



GHG Reduction Diagram for Canada – Aggregate Wedges

NRTEE, 2006-06



*National Roundtable on Environment and the Economy (NRTEE)
Report: Advice on a Long-term Strategy on Energy and Climate Change, 2006*



Emerging Projects

Emerging Projects

Clean Coal, Gasification of Hydrocarbons, CO₂ Capture



- Many projects on the drawing boards, in progress
- **Clean Coal**
 - EPCOR : Front End Engineering Design Study for a utility-scale (400 MW) coal gasification plant – announced 2006
 - SaskPower – Front End Engineering Design Study for a 300 MW oxyfuel plant – announced 2006
 - TransAlta/EPCOR Keephills 3 Plant – supercritical plant, announced Mar 2006
 - Sherritt Dodds Roundhill Plant – announced Jan 2007
- **Gasification of Hydrocarbon By-Products**
 - Suncor Voyageur Upgrader – announced Nov 2001
 - Nexen/Opti Long Lake Plant – announced Feb 2003
 - North West Upgrading Plant – announced Feb 2005
 - Peace River Bluesky Project – announced Dec 2005
- **CO₂ Capture and Storage**
 - CanSolv Demo – announced Dec 2005
 - CO₂ Solutions Demo – announced Oct 2006



Key Messages

Key Messages



- National and international experts have identified CCS as a key solution to reduce GHG emissions – critically important for Canada
- In addition to capture of GHGs from power generation, broad range of point source applications
 - Oil sands, hydrogen production, polygeneration
 - Supports EOR, ECBM commercial projects
- S&T and policy gaps and needs are being addressed
- Extensive ongoing work to facilitate the development and deployment of CCS technology – EOR, clean coal are primary drivers
 - CCS Task Force to report in November 2007
- CCS facilitates the regulation of GHG reductions
- Ready to move ahead with demonstration projects and feasibility studies, many now in queue

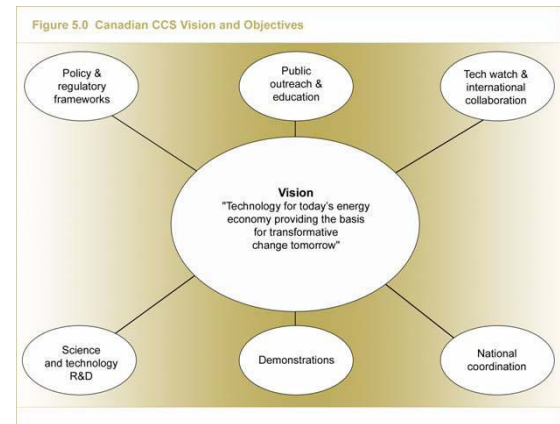
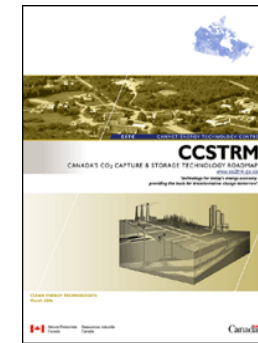


Annex

Canada's CO₂ Capture and Storage Technology Roadmap



- A snapshot for decision-makers and governments of opportunities for developing and deploying CCS
- Product of the 180+ experts – Canada, US, international, lead by NRCan-CETC
- Looks into all aspects of CCS technology ...
 - Role of CCS in Canada, globally
 - Opportunities for use of CCS technology
 - Current state of CCS technology
 - Specific technology needs and pathways
 - Critical next steps
- TRM proposes an integrated approach incorporating six key elements:
 - Policy and Regulatory Frameworks
 - Public Outreach and Education
 - Technology Watch and International Collaboration
 - Science and Technology R&D
 - Demonstration
 - National Coordination
- CCS is a technological solution that can provide immediate results to deal with today's energy and environmental needs while enabling Canada to move ever closer to a low-emissions energy future of tomorrow



Clean Coal Projects

Who's Involved

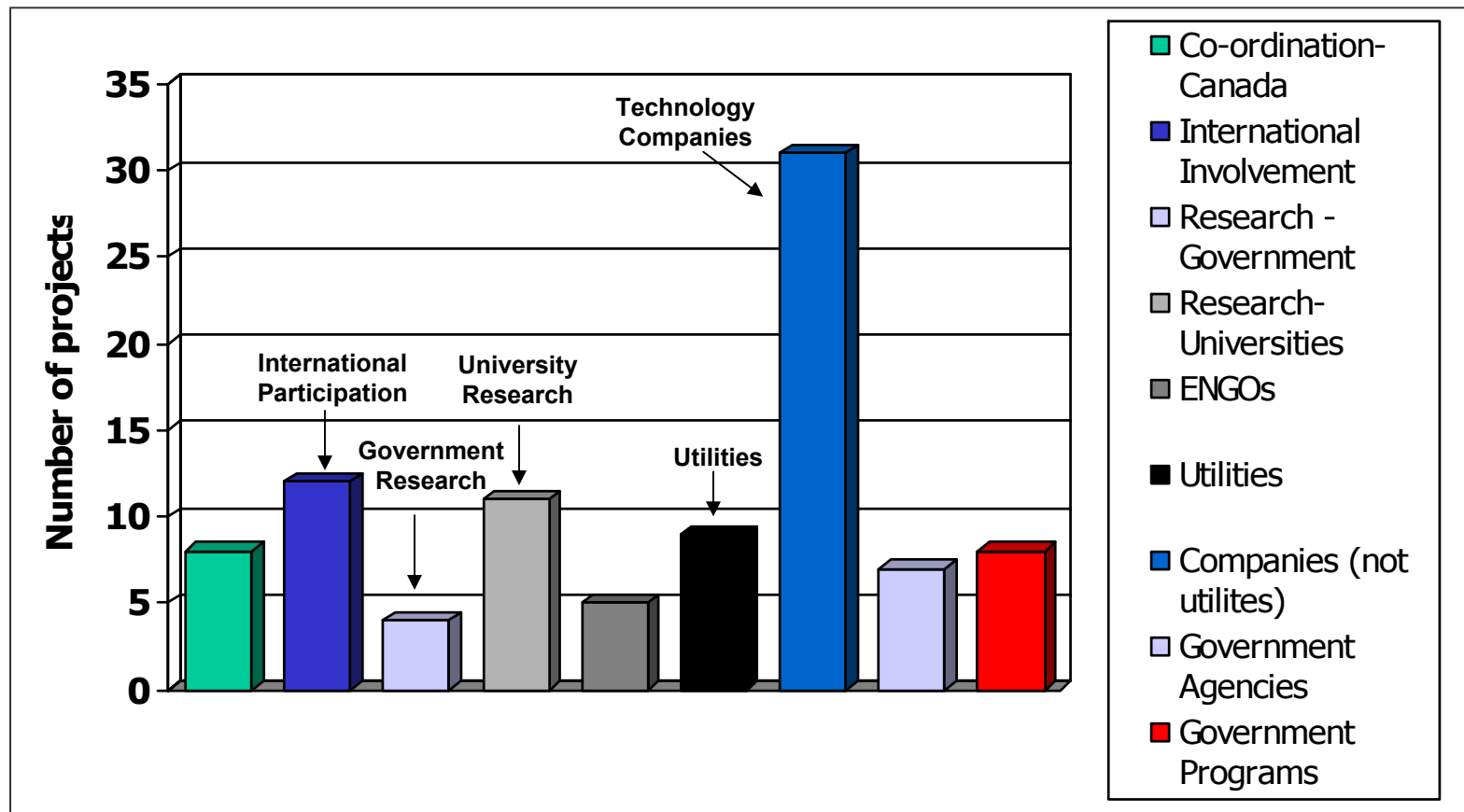


Figure 1: Distribution Projects - 95 organizations involved in Clean Coal Technologies

Clean Coal Projects

R&D Activity Dominates, Feasibility Studies Growing

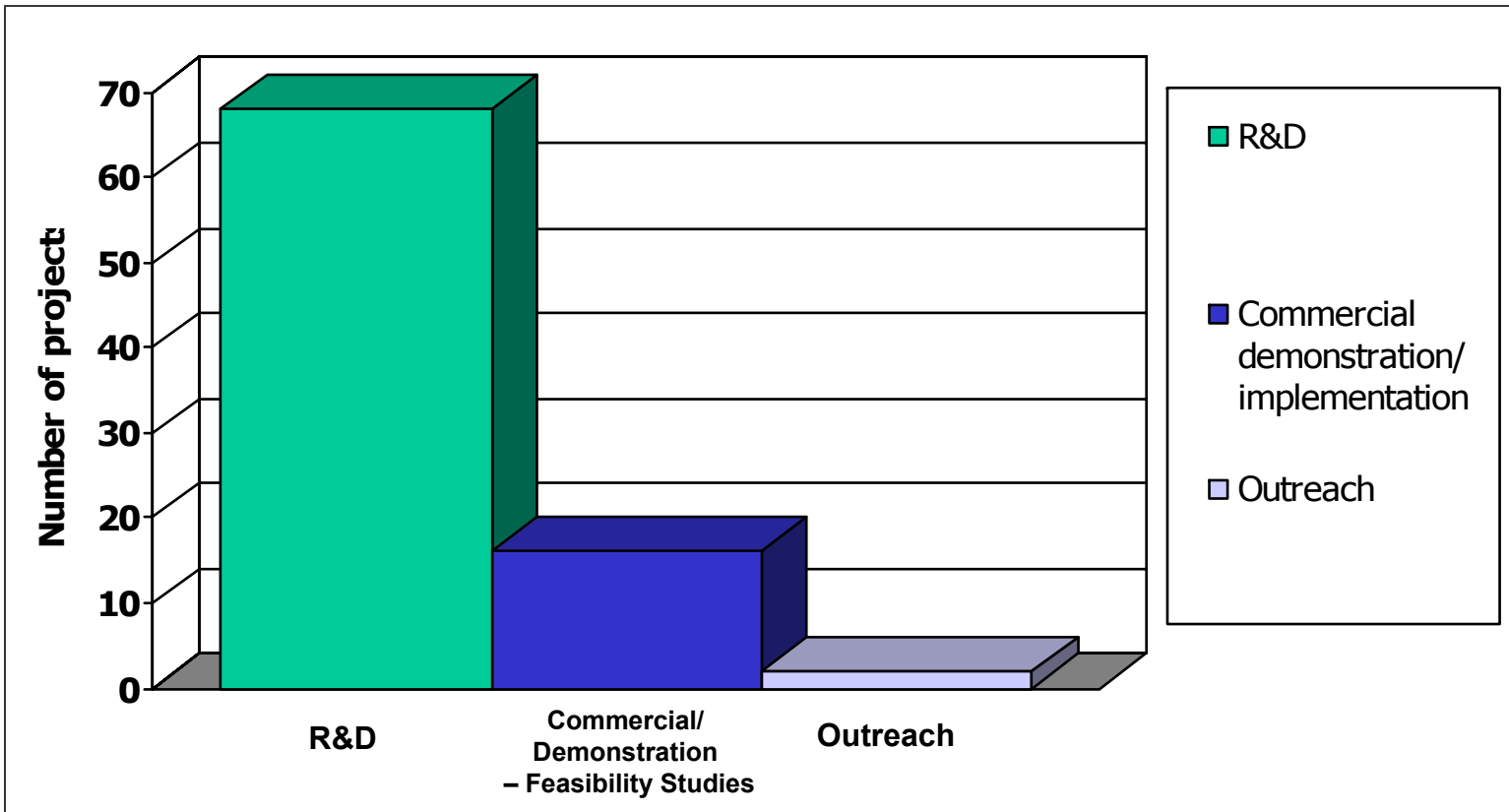


Figure 2: Distribution of the 86 Clean Coal Technology related projects by position in technology development and implementation cycle